H A

Notice of Allowability	Application No.	Applicant(s)	
	10/707,433	PETERS, ROBERT D.	
	Examiner	Art Unit	
	Tiffany A. Fetzner	2859	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☒ This communication is responsive to *the pre-appeal request of 12/27/2005 & the telephonic interview of 3/30/2006*.

2. ☒ The allowed claim(s) is/are *1-14,16-22 and 24-26*.

3. ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
   a) ☐ All b) ☐ Some* c) ☐ None of the:
      1. ☐ Certified copies of the priority documents have been received.
      2. ☐ Certified copies of the priority documents have been received in Application No. _____ .
      3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

   * Certified copies not received: _____.

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.
THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

4. ☐ A SUBSTITUTE OATH OR DECLARATION must be submitted. Note the attached EXAMINER'S AMENDMENT or NOTICE OF INFORMAL PATENT APPLICATION (PTO-152) which gives reason(s) why the oath or declaration is deficient.

5. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
   (a) ☐ including changes required by the Notice of Draftsperson's Patent Drawing Review (PTO-948) attached
      1) ☐ hereto or 2) ☐ to Paper No./Mail Date _____.
   (b) ☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date _____.

   Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).

6. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

1. ☒ Notice of References Cited (PTO-892)
2. ☐ Notice of Draftperson's Patent Drawing Review (PTO-948)
3. ☐ Information Disclosure Statements (PTO-1449 or PTO/SB/08), Paper No./Mail Date _____
4. ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material
5. ☐ Notice of Informal Patent Application (PTO-152)
6. ☒ Interview Summary (PTO-413), Paper No./Mail Date *03/30/2006* .
7. ☒ Examiner's Amendment/Comment
8. ☒ Examiner's Statement of Reasons for Allowance
9. ☐ Other _____.

Prosecution reopened finality of last office action withdrawn

1. In response to the Pre-Appeal brief request of **12/27/2005**, and the telephonic interview of **March 30th 2006** the finality of the previous Office action is hereby withdrawn and prosecution of the instant application is hereby reopened.

Examiner's Amendment

2. An examiner's amendment to the record appears below. Should the changes and/or additions be unacceptable to applicant, an amendment may be filed as provided by 37 CFR 1.312. To ensure consideration of such an amendment, it MUST be submitted no later than the payment of the issue fee.

3. Authorization for this examiner's amendment was given in a telephone interview with **Attorney J. Mark Wilkinson Reg. No. 48,865** on **March 30th 2006** along with authorization to charge any necessary fees to applicant's deposit account.

4. The application has been amended as follows:

A) Replace claim 1 of the **December 27th 2005** pre-appeal request pending claim list with the following **Examiner amended claim 1**:

Claim 1 ---A method comprising the steps of:

acquiring k-space data from multiple echoes in an echo train with a fast spin echo pulse sequence; **then**

correcting the acquired k-space data for amplitude modulation effects in the fast spin echo pulse sequence; and

2D Fourier transforming the corrected k-space data to form an image space from which an image is reconstructed. ---

B) Insert claims 2-3 of the December 27th 2005 pre-appeal request pending claim list:

Claim 2 ---The method of **claim 1** wherein the step of correcting includes the steps of:

acquiring at least one set of reference k-space data;

determining a table of amplitude modulation correction values; and

applying at least a portion of the table to the acquired k-space data. ---

Claim 3 ---The method of **claim 2** further comprising the steps of acquiring at least one set of reference k-space data before and after acquisition of the k-space data. ---

C) **Replace claim 4** of the **December 27th 2005** pre-appeal request pending claim list, with the following **Examiner amended claim 4**:

Claim 4 ---The method of **claim 2** further comprising the steps of:

acquiring at least one set of reference k-space data before acquisition of the k-space data; and

acquiring a second portion of the at least one set of reference k-space data after acquisition of the k-space data. ---

D) **Insert claims 5-10** of the **December 27th 2005** pre-appeal request pending claim list:

Claim 5 ---The method of **claim 2** wherein the at least one set of reference k-space data includes non-phase encoded data. ---

Claim 6 ---The method of **claim 2** wherein the steps of applying includes the steps of:

multiplying each k-space view of the acquired k-space data by a correction value in a corresponding ky location in the table; and

carrying out the steps of multiplying prior to transformation of the acquired k-space data from k-space to image space. ---

Claim 7 ---The method of **claim 2** wherein the at least one set of reference data includes two sets of reference data, and further comprising the steps of averaging the two sets of reference data to determine the table of correction values. ---

Claim 8 ---The method of **claim 5** wherein the at least one set of reference data represents a maximum achievable signal that the acquired phase encoded k-space data can attain. ---

Claim 9 ---The method of **claim 1** wherein the k-space data is acquired via multiple receiver coils, and further comprising the steps of correcting for amplitude modulation effects in the k-space data from each receiver coil independently. ---

Claim 10 ---The method of **claim 9** further comprising the steps of generating a combined image from corrected image data from each receiver coil. ---

E) **Replace claims 11-12** of the **December 27th 2005** pre-appeal request pending claim list with the following **Examiner amended claims 11** and **12**:

Claim 11 --- An MRI apparatus comprising:

a magnetic resonance imaging (MRI) system having a plurality of gradient coils positioned about a bore of a magnet to impress a polarizing magnetic field and an RF transceiver system and an RF switch controlled by a pulse module to transmit RF signals to an RF coil assembly to acquire MR images; and

a computer programmed to:

(A) acquire at least one set of reference MR data;

(B) determine a table of amplitude modulation correction values from the reference MR data;

(C) acquire MR data with a fast spin echo pulse sequence; and **then**

(D) modify the acquired MR data while the MR data is entirely in k-space by the table of amplitude modulation correction values to account for amplitude modulation effects in a fast spin echo pulse sequence played out to acquire the MR data. ---

Claim 12 ---The MRI apparatus of **claim 11** wherein the computer is further programmed to acquire the at least one set of reference MR data from one or more discarded acquisitions played out prior to **or** after acquisition of the MR data. ---

F) Insert claims 13-14 of the **December 27th 2005** pre-appeal request pending claim list:

Claim 13 ---The MRI apparatus of **claim 11** wherein the computer is further programmed to acquire portions of the at least one set of reference MR data prior to and after acquisition of the MR data. ---

Claim 14 ---The MRI apparatus of **claim 11** wherein the at least one set of reference MR data includes non-phase encoded data and the acquired MR data is modified while in k-space. ---

G) **Cancel claim 15** as noted in the **December 27th 2005** pre-appeal request:

H) **Insert claims 16-18** of the **December 27th 2005** pre-appeal request pending claim list:

Claim 16 ---The MRI apparatus of **claim 11** wherein the RF coil assembly includes a phased array of receiver coils. ---

Claim 17 ---The MRI apparatus of **claim 16** wherein the computer is further programmed to carry out acts (A)-(D) independently for each receiver coil. ---

Claim 18 ---The MRI apparatus of **claim 11** wherein the computer is further programmed to generate an image space from the modified MR data. ---

I) **Replace claims 19-20** of the **December 27th 2005** pre-appeal request pending claim list with the following **Examiner amended claims 19** and **20**:

Claim 19 ---A computer readable storage medium having a computer program to execute a fast spin echo pulse sequence stored thereon and representing a set of instructions that when executed by a computer causes the computer to:

acquire non-phase encoded MR data;

acquire phase encoded MR data from multiple echoes **with the fast spin echo pulse sequence**;

generate a set of amplitude correction values from the non-phase encoded MR data;

arrange the set of amplitude correction values in a table dimensionally equivalent to a k-space of phase encoded MR data; and **then**

modify the phase encoded MR data by the non-phase encoded MR data to correct amplitude modulation between the multiple echoes by modifying each data point of k-space with a similarly positioned amplitude correction value. ---

Claim 20 ---The computer readable storage medium of **claim 19** wherein the set of instructions further causes the computer to acquire the non-phase encoded MR data from a series of discarded acquisitions played out before **or** after acquisition of the phase encoded MR data. ---

J) **Insert claims 21-22** of the **December 27th 2005** pre-appeal request pending claim list:

Claim 21 ---The computer readable storage medium of **claim 19** wherein the phase encoded data includes one of 2D and 3D MR data. ---

Claim 22 ---The computer readable storage medium of **claim 19** wherein the

non-phase encoded MR data represents a maximum achievable signal that the phase encoded MR data can attain. ---

K) **Cancel claim 23** as noted in the **December 27th 2005** pre-appeal request.

L) **Insert claims 24-26** of the **December 27th 2005** pre-appeal request pending claim list:

Claim 24 ---The computer readable storage medium of **claim 19** wherein the set of instructions further causes the computer to amplitude correct acquired phased encoded MR data without increasing scan time. ---

Claim 25 ---The computer readable storage medium of **claim 19** wherein the set of instructions further causes the computer to carry out a pre-scan of a subject and acquire the non-phase encoded MR data after the pre-scan but before acquisition of the phase encoded MR data. ---

Claim 26 ---The computer readable storage medium of **claim 19** incorporated into a computer data signal embodied in a carrier wave that is uploadable/downloadable to an MR imaging system. ---

The following is an examiner's statement of **Reasons for Allowance**:

5. With respect to **Examiner amended independent claims 1, 11,** and **19:** These **Examiner amended independent claims** are considered to be allowable over the prior art of record because the prior art of record, and specifically the **Le Roux et al.,** article "Stabilization of Echo Amplitudes is FSE Sequences" Magnetic Resonance in Medicine volume 30 1993 pages 183-191; (hereafter **Le Roux et al.,** article), or the **Le Roux et al.,** patents noted below, do not disclose or suggest the entire method, the entire MRI apparatus, or the entire computer implementation of:

A) Examiner amended claim 1 ---A method comprising the steps of: acquiring k-space data from multiple echoes in an echo train with a fast spin echo pulse sequence; **then** correcting the acquired k-space data for amplitude modulation effects in the fast spin echo pulse sequence; and 2D Fourier transforming the corrected k-space data to form an image space from which an image is reconstructed. ---

B) Examiner amended claim 11 --- An MRI apparatus comprising:

a magnetic resonance imaging (MRI) system having a plurality of gradient coils positioned about a bore of a magnet to impress a polarizing magnetic field and an RF transceiver system and an RF switch controlled by a pulse module to transmit RF signals to an RF coil assembly to acquire MR images; and

a computer programmed to:

(A) acquire at least one set of reference MR data;

(B) determine a table of amplitude modulation correction values from the reference MR data;

(C) acquire MR data with a fast spin echo pulse sequence; and **then**

(D) modify the acquired MR data while the MR data is entirely in k-space by the table of amplitude modulation correction values to account for amplitude modulation effects in a fast spin echo pulse sequence played out to acquire the MR data. --- Or

C) Examiner amended claim 19 ---A computer readable storage medium having a computer program to execute a fast spin echo pulse sequence stored thereon and representing a set of instructions that when executed by a computer causes the computer to:

acquire non-phase encoded MR data;

acquire phase encoded MR data from multiple echoes **with the fast spin echo pulse sequence**;

generate a set of amplitude correction values from the non-phase encoded MR data;

arrange the set of amplitude correction values in a table dimensionally equivalent to a k-space of phase encoded MR data; and **then**

modify the phase encoded MR data by the non-phase encoded MR data to correct amplitude modulation between the multiple echoes by modifying each data point of k-space with a similarly positioned amplitude correction value. ---," in combination. **It is the combination of all of the claim limitations taken as a whole that constitutes both the novelty and non-obviousness of each of applicant's Examiner amended independent claims.**

6. The examiner notes that the word "then" in the **amended independent claims** clarifies that the correcting step, occurs after the entire "acquisition of the k-space data with the fast spin echo pulse sequence", which is distinct from the **Le Roux et al**., article, or the **Le Roux et al**., patents in which corrections to the k-space data occur while the fast-spin-echo sequence is still being performed, impacting the acquisitions of current and future k-space data, as a result of previously acquired data from earlier in the same fast spin echo pulse sequence. The main difference between the **Le Roux et al**., prior arts and applicant's inventive method is that in applicant's method "past" or "acquired" k-space data is corrected **after, the complete k-space data** for the FSE sequence being performed is acquired.

7. Applicant's inventive method impacts past or previously acquired k-space data, as opposed to future k-space acquisitions within the same sequence. It would not have been obvious to one of ordinary skill in the art at the time that the invention was made, to perform a past / acquired k-space data correction and amplitude modification as set forth by applicant in the examiner amended independent claims because, the prior art does not consider how to correct data, for amplitude modulation errors of an earlier executed FSE sequence's previously acquired k-space data. Therefore applicant's

examiner amended independent claims (i.e. **claims 1, 11,** and **19**) and their respective **amended or unchanged dependent claims** (i.e. **claims 2-10, 12-14, 16-18, 20-22,** and **24-26**) are considered to be novel and non-obvious over the prior arts of record.

8. With respect to **dependent claims 2-10, 12-14, 16-18. 20-22,** and **24-26**, from the **December 27th 2005** pre-appeal request response, each of these claims are considered by the examiner to be allowable over the prior art of record because they each depend from an **examiner amended independent claim** that is considered to be allowable over the **prior art of record**.

9. Any comments considered necessary by applicant must be submitted no later than the payment of the issue fee and, to avoid processing delays, should preferably accompany the issue fee. Such submissions should be clearly labeled "Comments on Statement of Reasons for Allowance."

Examiner's Comment

Information Disclosure Statement

10. The information disclosure statement (IDS) submitted on 12/22/2003 was in compliance with the provisions of 37 CFR 1.97. Accordingly, as noted in the previous June 10th 2005 office action, the examiner has already considered the information disclosure statement of 12/22/2003. [The initialed and dated IDS was previously attached the previous June 10th 2005 office action].

Drawings

11. The Official Draftsperson has already approved the drawings filed 03/28/2005 as noted in the previous June 10th 2005 office action.

Response to Arguments

12. Applicant's arguments see the Remarks, filed 12/27/2005, with respect to the **Le Roux et al**., article "Stabilization of Echo Amplitudes is FSE Sequences" Magnetic Resonance in Medicine volume 30 1993 pages 183-191; in view of, and in combination with the examiner amendments made herein, have been fully considered and are, **given the examiner's amendments above persuasive,** since applicant has now clarified that in applicant's method, MRI apparatus and computer implementation that

the correction of the "acquired k-space data for amplitude modulation effects" occurs after the "acquisition of the k-space data from multiple echoes in an echo train with a fast spin echo pulse sequence" has been performed.

Prior Art of Record

13. The **prior art made of record** and not relied upon (i.e. See the attached PTO 892) is considered pertinent to applicant's disclosure.

A) **Kuhara** US patent 4,859,946 issued August 22nd 1989.

B) **Maier et al.,** German DE patent 4436801 A1 published 20th April 1995, which is equivalent to **Sandford et al**., US patent 5451876 issued September 19th 1995.

C) **Zhang** US patent application publication 2003/0109781 A1 published June 12th 2003, filed December 11th 2001.

D) **Satoh** US patent 4,746,860 issued May 24th 1988.

E) **Ma et al.,** US patent 6,586,935 B1 issued July 1st 2003, filed May 31st 2000.

F) **Satoh** US patent 4,999,581 issued March 12th 1991.

G) **Zhou et al.,** US patent 6.064205 issued May 16th 2000.

H) **Zhou et al.,** US patent 5,923,168 issued July 13th 1999.

I) **Zhou et al.,** US patent 5,672,969 issued September 30th 1997.

J) ***Le Roux et al**., US patent 5,315,**249** issued May 24th 1994;

K) **Liu et al.,** US patent 5,621,321 issued April 15th 1997.

L) ***Le Roux et al**., article "Stabilization of Echo Amplitudes is FSE Sequences" Magnetic Resonance in Medicine volume 30 1993 pages 183-191.

M) ***Le Roux et al**., US patent 5,345,**176** issued September 6th 1994.

N) ***Sandford et al.,** US patent 5451876 issued September 19th 1995.

O) See all the additional references **cited of the attached PTO-948 Notice of References cited form** which is attached to this office action.

Conclusion

14. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Tiffany Fetzner whose telephone number is: (571) 272-

2241. The examiner can normally be reached on Monday-Thursday from 7:00am to 4:30pm., and on alternate Friday's from 7:00am to 3:30pm.

15. If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Diego Gutierrez, can be reached at (571) 272-2245. The **only official fax phone number** for the organization where this application or proceeding is assigned is **(571) 273-8300**.

16. Information regarding the status of an application may be obtained from the Patent Application information Retrieval (PAIR) system Status information for published applications may be obtained from either Private PMR or Public PMR. Status information for unpublished applications is available through Private PMR only. For more information about the PMR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PMR system contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

TAF
March 30, 2006

Diego Gutierrez
Supervisory Patent Examiner
Technology Center 2800